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Mt. Trumbull Ponderosa Pine

Restoration Project

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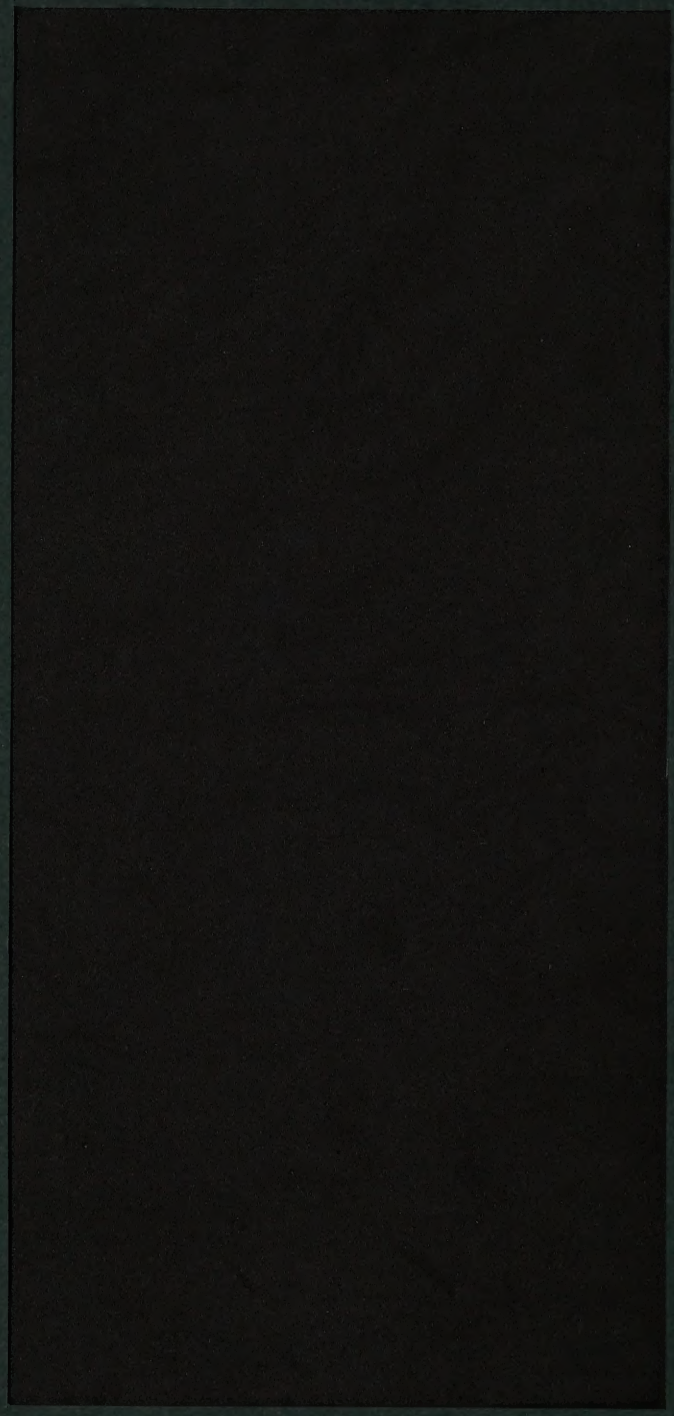

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SUMMARY

Ponderosa pine forest ecosystems in the Southwest are threatened by uncontrollable wildfires and insect outbreaks. Because of changes initiated by grazing, logging, and fire suppression, southwestern forests have become dense with stressed, slow-growing trees. Forest floor fuel loadings have climbed to catastrophic levels, while the diverse herbaceous plant communities and the animals dependent upon them are being choked out of the ecosystem. To develop the scientific basis for the practical restoration of ecological health to southwestern forests, the Mt. Trumbull project was undertaken using the following:

- A systematic analysis of the changes in southwestern forests since disruption of the natural regime of frequent, low-intensity fires.
- A comparison of the effects of current disturbances--wildfire, bark beetle mortality, thinning, and prescribed fire--to see if modern disturbed ecosystems can return to health.
- Initiation of carefully planned and monitored ecological restoration treatments.
- A landscape ecosystem scale approach to replicate natural self-vegetating patterns of forest structure and function, including plant and wildlife habitats and nutrient cycles.

This approach will lay the groundwork for integrated ecosystem management, providing scientists, managers, and the public with tested procedures for restoring ecosystem health.

The Arizona Strip Field Office, Bureau of Land Management (BLM), is working cooperatively with Northern Arizona University (NAU), Arizona Game and Fish Department (AGFD), and a steering committee of diverse interests to accomplish this project.

BACKGROUND

Just after the turn of the century, the Roosevelt Administration gathered huge acreages of public lands and placed them in the National Forest System, as either national forests or forest reserves. If an area grew trees, it qualified. In 1908 the Virgin Mountains, Black Rock, Poverty Mtn., Hudson Peak, Parashant, and Mt. Trumbull were included in what was called a forest reserve administered by the Dixie National Forest. The Wilson Administration decided to slim down the giant National Forest System and in May of 1916 returned all but the Mt. Trumbull forest back to the public lands. The Mt. Trumbull forest was initially placed in the Dixie National Forest until it was incorporated into the Kaibab National Forest in March of 1924. This little island forest proved to be inefficient for the Forest Service and in 1973, the area was transferred to the BLM.

The Mt. Trumbull area contains 12,289 acres of ponderosa pine forest in both wilderness and non-wilderness areas. It is located approximately 60 miles southeast of St. George, Utah. The treatment areas are between the Mt. Trumbull and Mt. Logan Wilderness Areas *(See maps located at the end of this document).*

The Mt. Trumbull area was designated in the Arizona Strip Resource Management Plan (RMP, 1992) as a Resource Conservation Area (RCA) with a commitment to take further actions to resolve ponderosa pine, wildlife, and recreation issues. The RMP states that the area will be managed for the enhancement of uses other than lumber production. An interdisciplinary team, by consensus, has set a goal to maintain a healthy ecosystem and increase bio-diversity while meeting human needs. The team also identified issues and objectives for the area. The most significant issue being the threat of catastrophic fire.

In developing management actions for the area, NAU scientists were requested to assist the team. NAU has become a major partner in this project and is providing guidance on how to do ecosystem restoration treatments and is establishing monitoring plots to determine the effects of the treatments. An adaptive management approach is being used, wherein future management actions are adjusted when scientific monitoring and evaluations indicate a need.

PRESETTLEMENT CONDITIONS

Ponderosa pine forests of the Southwest have gone through extensive structural and compositional changes in the last century. Many references document the open, park-like appearance of historic ponderosa pine stands where herbaceous vegetation was vigorous and abundant. The dense thickets of stagnant small ponderosa pine common throughout the Southwest and much of the more vigorous small size classes are due to a combination of events in the early 1900s. Many of the thickets originated around 1919, when a rare combination of factors occurred. A good seed production year in 1918 was followed by unusually moist springs for a few years that benefited the establishment and growth of pine seedlings (Rapport and Yazvenko, 1995).

The Mt. Trumbull forest has a logging history dating back to the 1870s. However, the area, reverently called "the Old Folks Home," has never been logged *(See photos at the end of this document)*. This stand is the closest approximation that we could find to presettlement conditions. The stand has not seen a fire in many decades. Centuries ago, natural fires would have eliminated the thick duff underneath the trees and replaced it with an understory of grasses and forbs. One thing we have learned about ponderosa pine is that diameter is not a function of age. A tree a foot smaller in diameter could be a hundred years older than its neighbor. All of the "yellow barks" appear to be similar in age, but could be as much as 300 years difference in age. The literature states that ponderosa pine is a fire-tolerant species. And it is, if there have been periodic fires to keep the fuel loading down. With the heavy needle duff that exists today, the Old Folks Home would not be fire tolerant. So much heat would build up at the base of these trees that the cambium layer would literally bake, killing the tree.

Fire-scarred samples were collected from stumps, logs, and living trees across approximately 150 acres surrounding the demonstration area in 1995. In the lab, samples were surfaced and cross-dated with tree-ring chronologies from Mt. Trumbull and northern Arizona. The date of each fire scar was determined and, where possible, the season of fire occurrence based on the relative position of the scar within the annual ring was also recorded. Preliminary fire history results based on 19 samples show a frequent fire regime from 1618-1869, with widespread fire occurrence ending about the time of Euro-American entry. Fire data is summarized below *(Also see chart at the end of this document).*

Category	MFI[1]	Minimum	Maximum	WMPI[2]
All scars	3.9 years	1 year	9 years	3.8 years
10% scarred	4.1 years	1 year	9 years	4.0 years
25% scarred	5.3 years	1 year	26 years	4.9 years

[1]Mean Fire Interval
[2]Weibull Median Probability Interval

OBJECTIVES

The ponderosa pine ecosystem restoration project in the Mt. Trumbull area will provide information necessary for answering the question, "Can ecosystem restoration alleviate the negative environmental consequences of fire regime disruption and restore ecosystem health, and do so in an economically, socially, and politically cost-effective manner?"

Ecological restoration rests upon the premise that the entire ecosystem will function best under the conditions that its component organisms have become adapted to over evolutionary time. Restoration does not mean that the ecosystem can be returned completely to the presettlement era nor does it imply a rigid, uniform prescription for management of every acre of forest land. For ponderosa pine forests, ecosystem restoration implies that dense patches of postsettlement trees should be thinned to promote tree and grass growth and vigor; that native grasses, shrubs, and

wild flowers be encouraged to provide forage for wild and domestic animals, as well as, enriching the soil and holding moisture; that a range of tree ages, especially of the oldest trees, be maintained to ensure habitat and genetic diversity; that heavy, unnatural postsettlement fuels be treated; and that prescribed fire be reintroduced on regular intervals to carry out its natural role (Covington, 1995).

ECOSYSTEM RESTORATION

This is the first large-scale ecological restoration project undertaken in the southwest. Here we outline the background of the project, the key ecological components studied, and the specific research studies initiated.

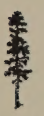
What is ecological restoration ?

To conserve ecosystem integrity, the coevolved diversity of life, "...the first step is to reconstruct a sample of what we had to begin with..."(Aldo Leopold).

"Ecological restoration is the process of reestablishing to the extent possible the structure, function, and integrity of indigenous ecosystems and the sustaining habitats that they provide" (Society of Ecological Restoration 1993).

Why is restoration of some long - needled pine ecosystems necessary ?

Western long-needled pine forests, especially ponderosa and Jeffrey pine ecosystems, have declined in diversity and productivity following exclusion of the natural low-intensity fires with which they evolved. Livestock grazing, logging, and wildfire suppression initiated by Euro-American settlers in the late 19th century, have led to increased density of young trees at the expense of old trees, grasses, wildflowers, and shrubs. Food webs have been altered as insects, birds, and other animals adapted to open forests with a diversity of plants now encountered a new habitat of dense trees.



Dense contemporary forests with accumulated fuels are not sustainable. Today wildfires often burn with high intensity killing everything in their path, destroying habitat for animals, birds, and insects, and exacting a high social and economic cost.

The window of opportunity for intervention may be as short as 15-30 years because of the precarious condition of many ponderosa pine forests and the current high mortality of the slowest organismic variables in the ecosystem (presettlement-era pine, oak, and juniper trees, 600+ years old). Since immediate action is needed, ecological restoration occurs in a "crisis" atmosphere where "one must act before knowing all the facts; crisis disciplines

are thus a mixture of science and art, and their pursuit requires intuition as well as information" (Soule 1985) and accepting uncertainty.

Restoration to the ecological conditions characteristic of the evolutionary environment is not necessarily a universal goal for all ecosystems. However, at least some natural landscapes are crucial to serve as benchmarks for comparison with altered systems and as a frame of reference for selecting management alternatives.

A landscape/ecosystem-scale approach is essential to replicate the natural self-regulating patterns of forest structure and function, including plant and wildlife habitats, cycles of nutrients, seasons and spatial patterns of fire, and to test hypotheses regarding mobile populations and landscape dynamics.

Research Design

The adaptive ecological restoration experiment will test the general hypothesis that ecosystem restoration in ponderosa pine can restore ecosystem health, reduce crown fire risk, and enhance indigenous biodiversity, while improving human habitats.

Management actions are undertaken in an environment of uncertainty. Better decisions are made using an active adaptive process in which deliberate monitoring and evaluation feed back into ongoing management activities. This "learning by doing" approach integrates research and management efforts (Walters and Holling 1990). It has been accepted as the model for ecosystem management both by public agencies and the Ecological Society of America (ESA 1996).

Ecological restoration treatments for southwestern ponderosa pine forests

The actions needed to restore ponderosa ecosystems have been a matter of considerable debate. One line of thought has been that no action is necessary, assuming that "natural" events such as severe wildfires will restore natural ecosystem structures and processes. Other attempts have been based on piecemeal methods, such as prescribed burning to reduce fuels or thinning to improve tree growth. However, these approaches have proven inadequate to address the diversity and complexity of ecosystems. As a single example, the re-introduction of prescribed fire at Chimney Spring in northern Arizona led to the death of 60-70 percent of the old-growth trees due to the high heat created by fire smoldering in the 12-18 inch deep fuel mound accumulated around the tree trunks from over 100 years of fire exclusion (Harrington and Sackett 1990).

Actions which are appropriate from an ecosystem management perspective require attention to the broad range of ecosystem components, especially the key structures and processes which most influence ecosystem function. The integrated set of treatments described below is based on research and observations over many years. While these prescriptions represent extensive accumulated experience, the intent of the adaptive ecosystem management approach is to ensure change, as the effects of initial actions are

followed through time and the information gained is used to refine and improve future restoration practices.

The restoration of ecosystem overstory structure: in most cases requires removal of dense, young trees, although in some circumstances tree planting may be necessary, such as after intense fires, clearcutting, or high mortality from pathogens. The presettlement tree pattern, evident in the living and dead trees of presettlement origin, is used as a template for reconstruction not only of presettlement density but also spatial pattern, restoring the clumpy structure of presettlement forests.

The restoration of ecosystem dead biomass structure: involves treating accumulated fuels to prevent unnatural fire effects. In particular, presettlement trees surrounded by heavy forest floor material are protected from fire girdling by removal of excessive fuels two to four feet away from the trunk.

The restoration of fire disturbance regimes: involves the re-introduction of fire in prescription to the forest after overstory and fuel treatments are complete. Prescribed fires can emulate presettlement fire patterns for the first few burns, with an eventual goal of permitting large areas to burn from natural ignitions during the normal fire season.

Restoration of ecosystem understory structure: shrubs and herbaceous plants respond rapidly when competing trees are thinned. However, the severely degraded conditions of contemporary ecosystems require that livestock grazing, where permitted, be deferred for at least several years until the herbaceous community is well established. Transplanting and seeding with native species as well as elimination of aggressive exotic weeds, may also be necessary to restore the understory.

Restoration of habitats: as vegetation structures and disturbance regimes are returned to conditions consistent with their evolutionary environment, habitats for insects, birds, other vertebrates, and humans will also change. In general, these changes should be favorable to the animals which coevolved as part of the ponderosa pine ecosystem. For species dependent on forage, fruit, and seeds from diverse shrubs and herbs, such as many insects, small mammals, and birds, resources will increase. Tree-dependent species, such as bark beetles and squirrels, will lose resource biomass. Careful monitoring of animals across different trophic levels is important to assess the effects of restoration treatment on animal populations.

MT. TRUMBULL ECOSYSTEM RESTORATION MARKING CRITERIA

Leave tree marking is utilized by leaving all living presettlement trees (old growth), and snags of all species which are retained for wildlife habitat. Originally, all trees regardless of size were removed if they did not qualify as presettlement or as a replacement. Currently, all trees 22 inches in diameter or greater are retained in restoration units.

Ponderosa Pine Marking Criteria

1) The most reliable characteristic of a presettlement ponderosa is yellowed bark. All of these are retained. Size is not an accurate indicator of age in ponderosa pine.

2) All trees of questionable age are cored to get an accurate age reading.

3) For each dead presettlement pine (stump, snag, etc.), 1.5 postsettlement trees on average were marked as replacement.

4) Where replacement trees are smaller than 16" d.b.h., three trees would replace each presettlement remnant. Biomass comparisons indicate that this ratio would maintain an adequate replacement of foliage, bark, and branch biomass.

5) Replacements were selected from the largest, healthiest trees within a 30 to 60 foot radius of the stump or snag. Replacement trees would be selected first from within a 30 foot search radius surrounding dead presettlement material. If larger replacement trees are available within the 60 foot radius, these trees would be marked for retention.

6) When replacements could not be found within that search radius, they were carried over to the next group.

Gambel Oak Marking Criteria

1) All Gambel oak 10 inches in diameter (breast height) or greater are considered to be of presettlement origin (old growth). These are all retained.

2) When evidence of a dead presettlement oak was found, the two largest oak stems within a 15 foot radius were marked as replacements.

3) Most oak clones are regarded as of presettlement origin even if no large diameter dead stem is visible. In all clones, the two largest stems were marked for retention.

4) Rather than thinning oak concurrently with ponderosa pine, oak would only be thinned following the first entry with prescribed fire.

Pinyon and Juniper Marking Criteria

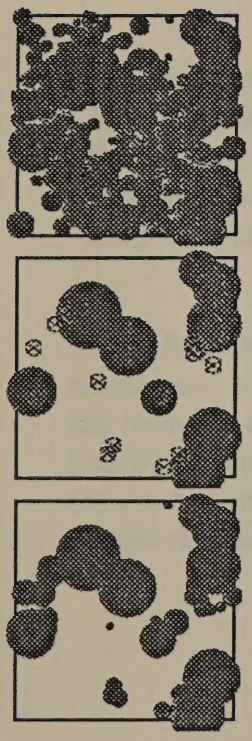
1) All juniper over 12 inches in diameter at the root collar were retained as presettlement trees.

2) All pinyon pine over 10 inches diameter at breast height were retained as presettlement trees.

3) When evidence of dead presettlement juniper or pinyon pine was found the two largest replacement trees within a 15 foot radius were marked as leave trees.

The following figure illustrates the use of the marking criteria.

Forest Health Restoration
Mt. Trumbull Demonstration Plot EAST
Preliminary Map - October 17, 1995



Forest Structure 1995

Live tree crowns are shaded on this demonstration plot. At this site in 1995 there were 1,122 live ponderosa pine trees per acre.

Presettlement Structure

Live crowns shaded and dead tree locations marked. On this plot, total presettlement forest density was 37 trees per arce, all pines.

Restoration Treatment

The restoration treatment marked here emulates the patchy presettlement forest structure. All presettlement trees and some replacement trees were retained. The treated plot has 73 pines per acres.

STUDIES

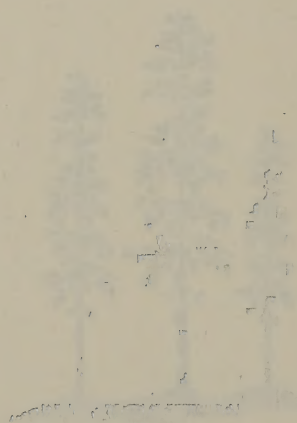
NAU is currently conducting the following studies in order to analyze changes in forest structure since disruption of the natural fire regime, and to determine the effects of restoration treatments upon ecosystem components:

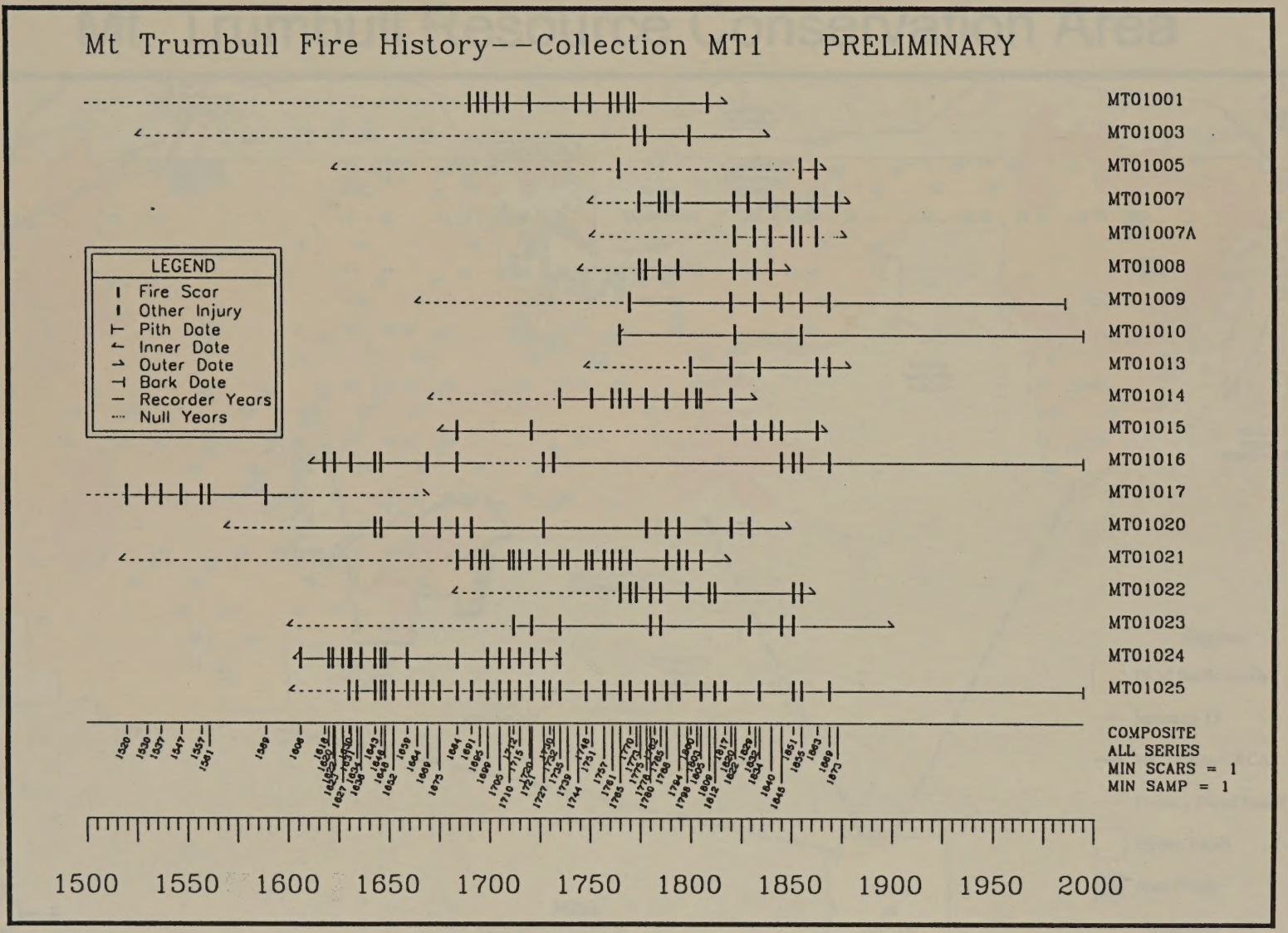
- Establishment of permanent ecosystem monitoring plots
- Passerine bird habitat and population responses to ecological restoration
- Restoration of grasses, wildflowers, and shrubs
- Insect response to ecological restoration
- Effects of high intensity fire
- Restoration of Gambel oak
- Potential wilderness restoration methods
- Dendroclimatic reconstruction
- Fire history
- Modeling forest structure change
- Fire ecology and forest structure in northern Mexico
- Long term persistence and stability of presettlement pine groups

The AGFD will begin working on the following studies during the 1997 field season to describe short term effects of restoration treatments on forest habitat characteristics, and develop habitat management recommendations for future restoration efforts in southwestern forests.

- Passerine bird studies
- Mule deer studies
- Kaibab squirrel studies
- Merriam's turkey studies
- Herpetofauna studies

The BLM is conducting a bat inventory and study to complement NAU and AGFD research. The objectives of this study are to identify and map key use areas of bats, identify and describe changes in bat populations and roost use due to ecosystem restoration treatments, and determining relative abundance of bat species in the area.

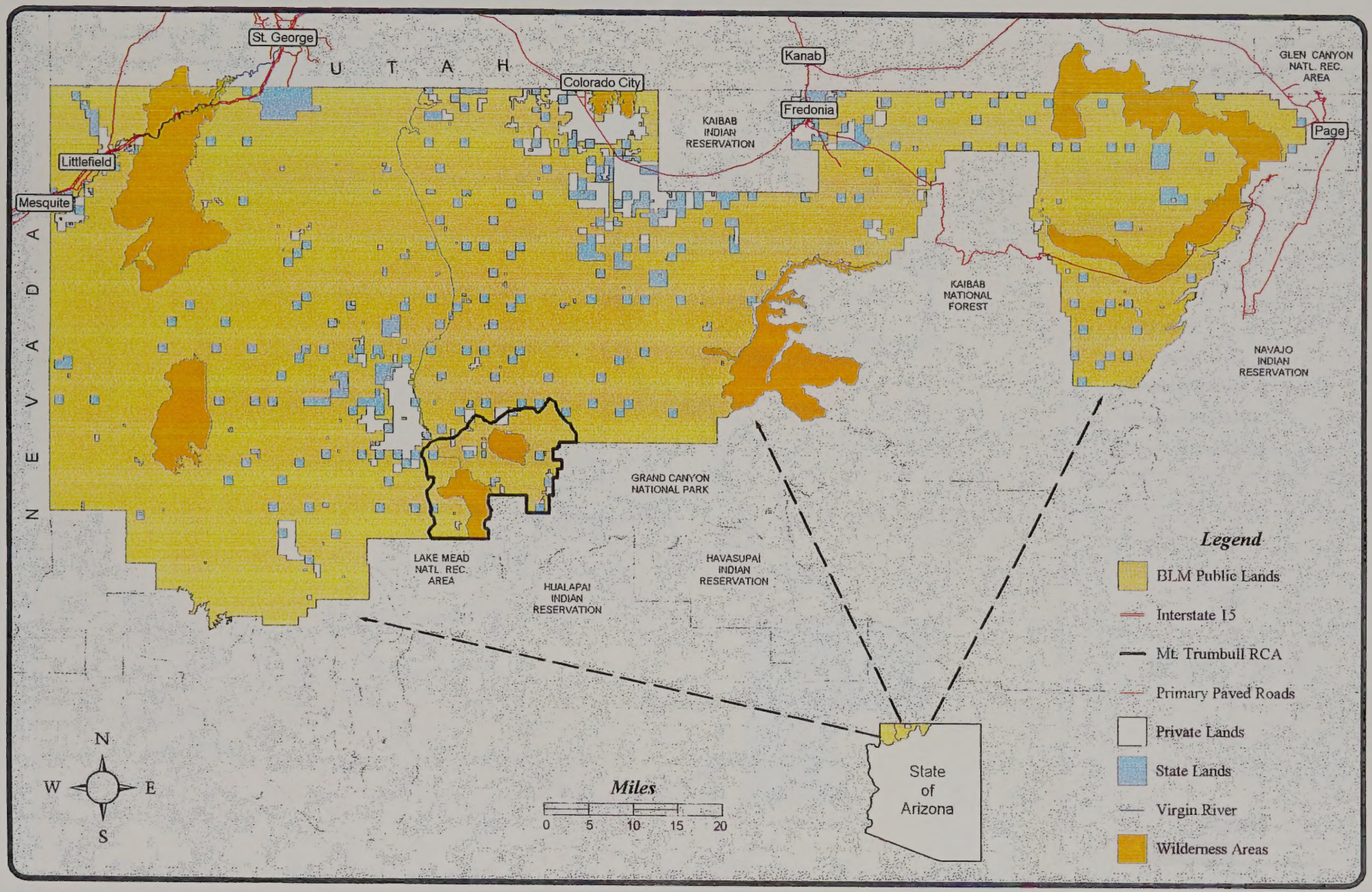




Preliminary fire history data from the Mount Trumbull Resource Conservation Area. Fire-scarred samples were collected in 1995. Sampling will extend throughout the ponderosa pine forest in 1996.

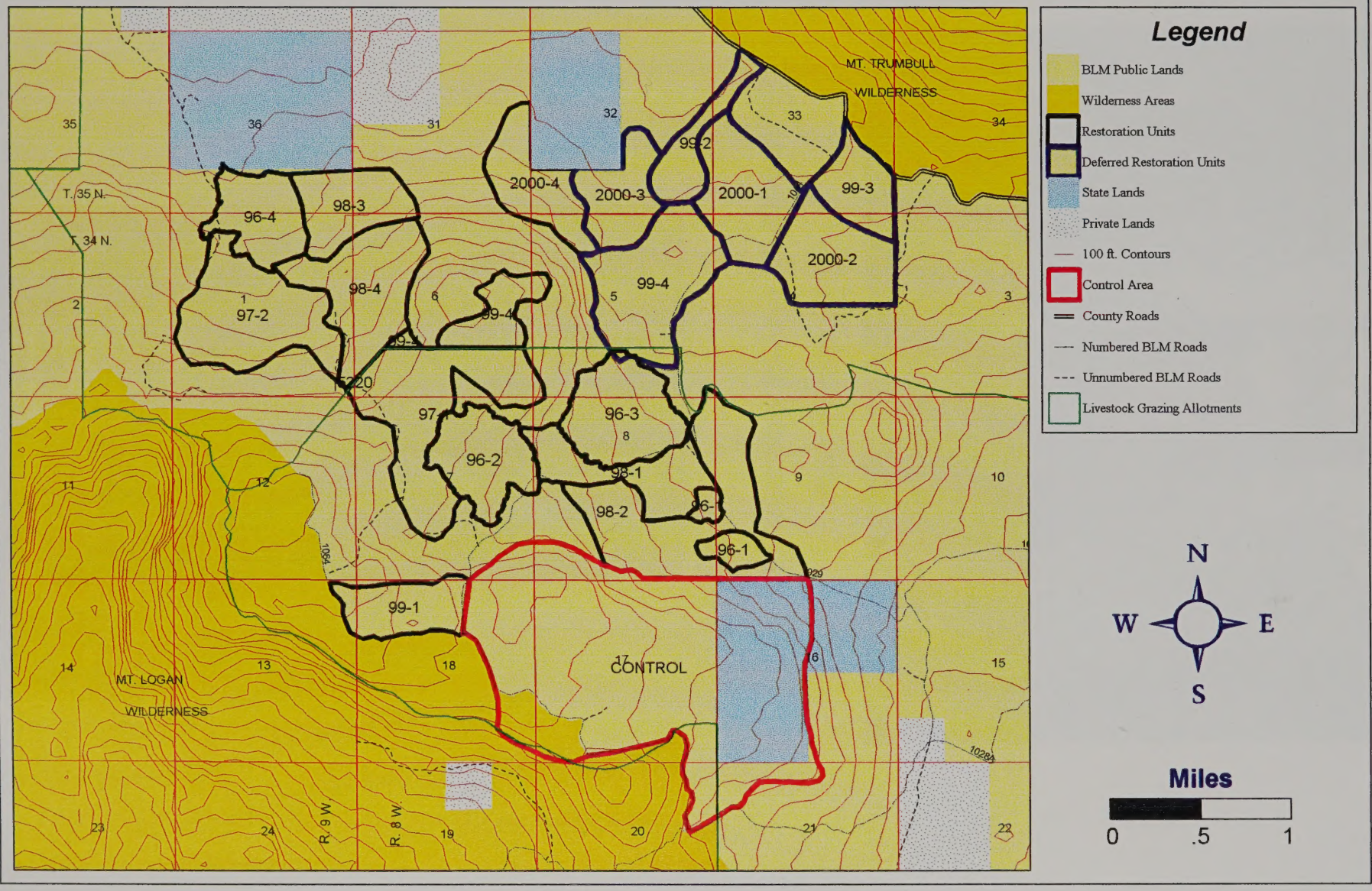
Arizona Strip District

Mt. Trumbull Resource Conservation Area



Mt. Trumbull RCA

Ponderosa Pine Ecosystem Restoration



Old Folks Home
(Example of Presettlement Forest)

Demonstration Area
(Before Treatment)